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(54) Manufacture of electrical insulating tapes and sheets

(57) A method of manufacturing an insulating tape or sheet suitable for permanently insulating bare surfaces comprising the steps of applying solvent-free resin incorporating a curing agent to a surface of a mica-paper backing and heating the resulting composite for a time and temperature sufficient to produce substantially complete penetration of the backing without curing the resin. The resin may be cured after the impregnated tape or paper has been applied to the bare surface of for example, an electrical conductor.

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SPECIFICATION

The manufacture of electrical insulating tapes and sheets

This invention relates to the manufacture of electrical insulating tapes or sheets of the kind comprising paper formed from reconstituted mica on a supporting backing of flexible insulating material, for example glass cloth, and impregnated with a thermosetting resin, usually an epoxy resin. Such tapes or sheets are commonly employed in the heavy electrical industry for example for insulating the windings of large dynamo-electric machines or transformers, the tape or sheet with the resin in an uncured or partially cured state, being wound or wrapped around the parts to be insulated, and then subjected to a heat treatment in order to fully cure the resin.

It is common in the manufacture of such tapes or sheets for the mica-paper/backing composite to be impregnated with a solution of the resin, together with a suitable curing agent which may be either a hardener or a catalyst, in a volatile solvent such as acetone or methyl ethyl ketone, the solvent being subsequently removed by passage of the impregnated composite through an oven.

However such a method possesses the following attendant disadvantages:—

1. The solvent is usually permitted to escape to the atmosphere during the drying stage which represents a serious monetary loss, and whilst it may in many cases be possible to employ equipment for recovering a proportion of the solvent, such equipment is inherently expensive to instal and operate.

2. Total removal of solvent to achieve optimum electrical properties is very difficult, and is often only effected at the expense of some unwanted pre-cure in the impregnated composite, with resultant loss of flexibility.

3. Deliveries of solvent can sometimes be erratic, and supplies from alternative sources may contain harmful contaminants, the analysis for which is expensive and time consuming.

According, therefore, to the present invention a method of manufacturing an insulating tape or sheet of the kind referred to employs a thermosetting resin substantially free of volatile solvents which, with its curing agent incorporated, has a viscosity such that it can be applied as a coating to a surface of the mica-paper or backing used to form the tape or sheet, and is such that under selected heating conditions its viscosity is reduced to cause it to impregnate the mica-paper, and said method includes the steps of coating the mica-paper or backing as the case may be and heating the mica-paper/backing/resin composite for a time and temperature sufficient to produce substantially complete penetration of the mica-paper by the resin without any appreciable pre-curing of the latter.

Manufacture is preferably carried out as a continuous process, and in the manufacture of tape this is conveniently initially formed as a continuous sheet which is subsequently slit into tapes. Thus in the manufacture of both sheets and tapes by such a process a composite sheet is fed through a heating zone maintained at an appropriate temperature and the speed at which the composite is fed being adjusted to ensure rapid and substantially complete impregnation of the mica-paper by the resin on its passage through the heating zone.

The actual time and temperatures employed in the heating stage for producing the most satisfactory results will of course, depend on the materials used for forming the sheet especially the resin, but may readily be ascertained by trial for any particular materials employed.

The treated composite may subsequently be batched, and slit into tapes if required, requiring no further treatment, such as vacuum drying, which needs to be carried out with existing methods of manufacture, in order to remove traces of solvent.

The resin coating may be applied to the mica-paper or the backing either before or after these materials are assembled to form the mica-paper/backing composite. Preferably, however, it is applied to a surface of the mica-paper before the latter and the backing are brought together, so as to be sandwiched between them.

Commonly the catalyst such as boron trifluoride complex such as BF_3MEA or other solid or semi-solid catalyst or hardener is introduced into an epoxy resin following the heating of the latter to reduce its viscosity. Satisfactory mixing is, however, difficult to achieve in some cases, and the temperature necessary to convert many resins to a sufficiently mobile liquid solvent form is in some cases close to the decomposition temperature of the hardener or reactive temperature of the catalyst used.

According, therefore, to another aspect of the invention the curing agent (hardener or catalyst) is dispersed throughout the resin by passage of the resin and curing agent through a suitable form of mill without application of heat for a time sufficient to achieve a thorough mixing of the agent and the resin. In some cases it may be advantageous to cool the mill during this process.

One method in accordance with the invention of manufacturing an insulating tape of the kind referred to will now be described by way of example.

A mica-paper strip or sheet is initially coated on one surface with an epoxy novolak-Dow DEN 431 incorporating BF_3MEA as hardener, the coating being carried out by means of a roller coating or trowelling machine at room temperature, the resin at this temperature having a viscosity of approximately 350 poises which permits a substantially uniform coating to be obtained.

Glass cloth is then laid on top of the resin coating, so that the latter is sandwiched between the mica-paper and glass cloth, and the mica-paper/resin/glass cloth composite is then passed through a heating zone or oven maintained at a temperature of the order of 80—100°C.

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The rate at which the composite is passed through the heating zone or oven is such that rapid and substantially total penetration of the paper by the resin is achieved, without any appreciable precuring of the resin.

The treated composite sheet may then be batched and slit, and since it maintains a high degree of flexibility is highly suited for winding round electrical conductors for effecting the insulation thereof, the resin finally being cured by heating the wound conductor to an appropriate temperature.

In some cases, however, the composite sheet may be subjected to additional heating during its initial formation to achieve a degree of precure where this is required for achieving a desired handling condition for certain applications.

The hardener is preferably introduced with the resin prior to the coating process by passing the resin/hardener mixture through a three-roll or other suitable mill, for example as are employed in paint manufacture, the mill conveniently being water cooled during this process.

This ensures the resin/hardener mixture receives thorough dispersion and the minimum of heat treatment other than that required to achieve sufficient impregnation of the mica-paper.

It will, however, be appreciated that the invention can be used to advantage with other forms of resin/hardener or catalyst compositions the times and temperatures being adjusted to achieve the most satisfactory results for any particular materials accordingly.

CLAIMS

1. A method of manufacturing an insulating tape or sheet of the type comprising paper formed from reconstituted mica on a supporting backing of flexible insulating material and impregnated with a thermosetting resin, employs a thermosetting resin substantially free of volatile solvents which, with its curing agent incorporated, has a viscosity such that it can be applied as a coating to a surface of the mica-paper or backing used to form the tape or sheet, and is such that under selected heating conditions its viscosity is reduced to cause it to impregnate the mica-paper, and said method includes the steps of coating the mica-paper or backing and heating the mica-paper/backing/resin composite for a time and temperature sufficient to produce substantially complete penetration of the mica-paper by the resin without any significant curing of the latter.

2. A method according to Claim 1 in which a sheet of the said composite is fed through a heating zone maintained at a temperature such that substantially complete impregnation of the mica-paper by the resin occurs during the passage of the composite through the heating zone.

3. A method according to Claim 1 or Claim 2 in which the thermosetting resin is applied to a surface of the mica-paper and the backing is subsequently applied to the said surface so as to sandwich the resin.

4. A method according to Claim 1 or Claim 2 in which the thermosetting resin is applied to a surface of the backing and the mica-paper is subsequently applied to the said surface so as to sandwich the resin.

5. A method according to any preceding Claim in which the curing agent is mechanically dispersed throughout the thermosetting resin at a temperature substantially lower than the curing temperature of the resin before the resin is applied to the mica-paper and/or backing.

6. A method according to Claim 5 in which the curing agent is dispersed throughout the resin by passing the resin and curing agent through a mill.

7. A method according to any preceding Claim which includes the additional step of heating said composite so as to partially cure the resin after the step of heating the resin and thereby impregnating the mica-paper.

8. A method according to any preceding Claim in which the backing consists of glass cloth.

9. A method according to any preceding Claim in which the viscosity of the resin is approximately 350 poises when it is applied to the mica-paper or backing.

10. A method according to any preceding Claim in which the resin is an epoxy resin, the curing agent is BF_3MEA, and the said composite is impregnated by the resin by being passed through an oven at a temperature of approximately 80—100°C.

11. A method of manufacturing an insulating tape or sheet of the kind referred to substantially as hereinbefore described by way of example.

12. An insulating tape or sheet manufactured in accordance with any preceding Claim.

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